

FORM PTO-1390
REV. 5-93US DEPARTMENT OF COMMERCE
PATENT AND TRADEMARK OFFICEATTORNEYS DOCKET NUMBER
P99,2690**TRANSMITTAL LETTER TO THE UNITED STATES
DESIGNATED/ELECTED OFFICE (DO/EO/US)
CONCERNING A FILING UNDER 35 U.S.C. 371**

U.S. APPLICATION NO. (if known, see 37 CFR 1.5)

09/446545INTERNATIONAL APPLICATION NO.
PCT/DE97/01740INTERNATIONAL FILING DATE
December 30, 1998PRIORITY DATE CLAIMED
June 24, 1997TITLE OF INVENTION **METHOD AND ARRANGEMENT FOR EFFECTIVE RADIO TRANSMISSION OF DATA**APPLICANT(S) FOR DO/EO/US **JUERGEN KOCKMANN, ANTON KRUK, HERMANN-JOSEF TERGLANE, UWE SYDON and PETER SCHLIWA**

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay.
4. ☐ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of International Application (35 U.S.C. 371(c)(2))
 - a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau).
 - b. ☒ has been transmitted by the International Bureau.
 - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US)
6. ☒ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. §371(c)(3))
 - a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
 - b. ☐ have been transmitted by the International Bureau.
 - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
 - d. ☐ have not been made and will not be made.
8. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)) (**attached at back of English translation of application**).
9. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☐ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 16. below concern other document(s) or information included:

11. ☐ An Information Disclosure Statement under 37 C.F.R. 1.97 and 1.98; (**PTO 1449, Prior Art, Search Report**).
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 C.F.R. 3.28 and 3.31 is included.
(SEE ATTACHED ENVELOPE)
13. ☐ A FIRST preliminary amendment.
☐ A SECOND or SUBSEQUENT preliminary amendment.
14. ☐ A substitute specification.
15. ☐ A change of power of attorney and/or address letter.
16. ☒ Other items or information:
 - a. ☒ Submission of Drawings
 - b. ☐ Request for Approval of Drawing Changes
 - c. ☒ Letter Under Rule Under 37 C.F.R. §1.41(c)
 - d. ☒ EXPRESS MAIL #EL408260753US

U.S. APPLICATION NO. (if known, see 37 C.F.R. 1.55) 09/446545		INTERNATIONAL APPLICATION NO. PCT/DE97/01740		ATTORNEY'S DOCKET NUMBER P99,2690	
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17. <input checked="" type="checkbox"/> The following fees are submitted: BASIC NATIONAL FEE (37 C.F.R. 1.492(a)(1)-(5): Search Report has been prepared by the EPO or JPO \$840.00 International preliminary examination fee paid to USPTO (37 C.F.R. 1.482) ... \$760.00 No international preliminary examination fee paid to USPTO (37 C.F.R. 1.482) but international search fee paid to USPTO (37 C.F.R. 1.445(a)(2)) \$450.00 Neither international preliminary examination fee (37 C.F.R. 1.482) nor international search fee (37 C.F.R. 1.445(a)(2)) paid to USPTO \$1,250.00 International preliminary examination fee paid to USPTO (37 C.F.R. 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4) \$ 98.00 <div style="text-align: right;">ENTER APPROPRIATE BASIC FEE AMOUNT =</div>				CALCULATIONS		PTO USE ONLY	
Surcharge of \$130.00 for furnishing the oath or declaration later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 C.F.R. 1.492(e)).				\$			
Claims	Number Filed	Number Extra	Rate				
Total Claims	10 - 20 =		X \$ 18.00	\$ 0.00			
Independent Claims	2 - 3 =		X \$ 78.00	\$ 0.00			
Multiple Dependent Claims			\$270.00 +	\$ 270.00			
TOTAL OF ABOVE CALCULATIONS =				\$1,110.00			
Reduction by 1/2 for filing by small entity, if applicable. Verified Small Entity statement must also be filed. (Note 37 C.F.R. 1.9, 1.27, 1.28)				\$			
SUBTOTAL =				\$1,110.00			
Processing fee of \$130.00 for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(f)).				+			
TOTAL NATIONAL FEE =				\$			
Fee for recording the enclosed assignment (37 C.F.R. 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 C.F.R. 3.28, 3.31). \$40.00 per property				+		SEE ATTACHED ENVELOPE	
TOTAL FEES ENCLOSED =				\$1,110.00			
				Amount to be refunded		\$	
				charged		\$	

a. ☒ A check in the amount of \$ 1,110.00 to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account No. _____ in the amount of \$ _____ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 08-2290. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 C.F.R. 1.494 or 1.495 has not been met, a petition to revive (37 C.F.R. 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

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SIGNATURE

NAME

28.982
Registration Number

HILL & SIMPSON

A PROFESSIONAL CORPORATION

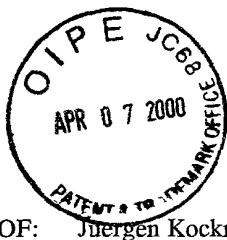
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IN RE APPLICATION OF: Juergen Kockmann, et al.

ATTORNEY DOCKET NO. P99,2690

SERIAL NO.: 09/446,545

GROUP ART UNIT:

FILED: December 22, 1999

EXAMINER:

FOR: "METHOD AND ARRANGEMENT FOR EFFECTIVE RADIO TRANSMISSION OF DATA"

PRELIMINARY AMENDMENT

5000

Hon. Assistant Commissioner of Patents

Washington D.C. 20231

SIR:

Transmitted herewith is an amendment in the above-identified application.

■ No additional claim fee is required.

The fee has been calculated as shown below.

CLAIMS AS AMENDED						
	(2) CLAIMS REMAINING AFTER AMENDMENT		(4) HIGHEST NO. PREVIOUSLY PAID FOR	(5) PRESENT EXTRA	(6) RATE	(7) ADDITIONAL FEE
TOTAL CLAIMS	* 10	MINUS	** 20		() X 9.00 () X 18.00	
INDEP. CLAIMS	* 1	MINUS	3		() X 39.00 () X 78.00	
Application amended to contain any multiple dependent claims not previously paid for.				() YES () NO	() \$130.00 () \$260.00 ONE TIME	
TOTAL ADDITIONAL FEE FOR THIS AMENDMENT						\$0.00

* If the entry in Column 2 is less than the entry in Column 4, write "0" in Column 5.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20 write "20" in this space.

- ☐ Applicant petitions the Commissioner of Patents and Trademarks to extend this time for response to the Office Action dated _____ for _____ month so that the period for response is extended to _____. A check in the amount of \$_____ is attached to cover the cost of the extension. Any deficiency or overpayment should be charged or credited to deposit account No. 08-2290. A duplicate copy of this sheet is enclosed.
- ☐ A check in the amount of \$_____ is attached to cover the additional claim fee.
- ☐ A check for \$_____ accompanying attached Terminal Disclaimer under 37 C.F.R. §1.321.
- ☐ A check for \$_____ for submission of a Supplemental IDS under 37 CFR 1.97(d) is attached.
- The Commissioner is hereby authorized to charge any additional fees which maybe required, or to credit any overpayment to account No. 08-2290. When phoning re this application, please call 312/876-0200 - Ext. 3261.

HILL & SIMPSON

A Professional Corporation

BY Steven H. Noll (Reg. No. 28,982)

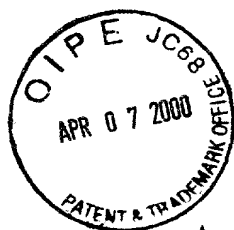
Steven H. Noll

CERTIFICATE OF MAILINGI hereby certify that this correspondence is being deposited with the United States Postal Service as First Class Mail in an envelope addressed to the Assistant Commissioner of Patents, Washington, D.C. 20231 on April 5, 2000.Steven H. Noll

SIGNATURE

April 5, 2000

3 / a



-1-

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

PRELIMINARY AMENDMENT "A"

Applicant(s): Juergen Kockman et al. Attorney Docket No.: P99,2690

Serial No.: 09/446,545 Group Art Unit: Unknown

5 Date Filed: December 22, 1999 Examiner: Unknown

Invention: "METHOD AND ARRANGEMENT FOR EFFECTIVE
RADIO TRANSMISSION OF DATA"

Hon. Assistant Commissioner for Patents

Washington, DC 20231

10 Sir:

Applicants herewith amend the above-referenced application, and request entry of the Amendment prior to examination.

IN THE SPECIFICATION:

15 On page 1, cancel the title and text above line 4, and insert the following text and amended title above line 4:

--TITLE

**METHOD AND ARRANGEMENT FOR EFFECTIVE RADIO
TRANSMISSION OF DATA**

BACKGROUND OF THE INVENTION--;

20 in line 7, cancel "plurality" substitute --number-- therefor;
in line 11, cancel "1990s" substitute --1990's-- therefor, and cancel
"analog" substitute --analog-- therefor;
in line 12, cancel "Standards" substitute --standards-- therefor;
in line 13, cancel "Standards" substitute --standards-- therefor.

25 On page 2, at the top of the page, cancel "GR 97 P 2121 P";
in line 12, after "with" insert a comma, and after "case" insert a comma.

On page 3, at the top of the page, cancel "GR 97 P 2121 P".

On page 4, at the top of the page, cancel "GR 97 P 2121 P";

in line 10, cancel "Standards" substitute --standards-- therefor;

in line 20, cancel "(=)-" substitute ---- therefor;

below line 23, insert a centered heading:

--SUMMARY OF THE INVENTION--;

5 below line 29, insert the following:

--This object is achieved in accordance with the present invention is a method for digital radio transmission of data between a fixed station and at least one mobile station at one of a number of carrier frequencies, said method comprising the steps of: transmitting data
10 in a number of time slots using a time-division multiplex method, said data being transmitted in active time slots each of which is followed by an inactive time slot in which no data is transmitted, said inactive time slot having a time duration shorter than a time duration of an active time slot; and changing from a first carrier
15 frequency to a second carrier frequency after a predetermined time period.

This object is also achieved in accordance with the present invention in an arrangement for digital radio transmission of data between a fixed station and at least one mobile station in a number of time slots
20 using the time-division multiplex method, and at a number of carrier frequencies using the frequency-division multiplex method, said arrangement comprising: a fixed station having a first RF module for choosing a carrier frequency for transmitting during one of said time slots, and for changing from a first carrier frequency to
25 a second carrier frequency during a predetermined time period on an order of magnitude of one time slot; at least one mobile station having a second RF module for choosing a carrier frequency for transmitting during one of said time slots, and for changing from said first carrier frequency to said second carrier frequency during
30 said predetermined time period on an order of magnitude of one time slot; and a transmission time frame having active time slots in

which data is transmitted, each of said active time slots being followed by an inactive time slot in which no data is transmitted, said inactive time slot having a time duration being shorter than that of a time duration of an active time slot.--;

- 5 in line 33, cancel "plurality" substitute --number-- therefor, and cancel
"are" substitute --is-- therefor;
in line 38, cancel "are" substitute --is-- therefor.

- 10 On page 5, at the top of the page, cancel "GR 97 P 2121 P";
in line 1, cancel "are" substitute --is-- therefor;
in line 20, cancel "plurality" substitute --number-- therefor;
in line 22, cancel "plurality" substitute --number-- therefor;
in line 31, cancel "are" substitute --is-- therefor;
in line 32, cancel "are" substitute --is-- therefor.

- 15 On page 6, at the top of the page, cancel "GR 97 P 2121 P";
cancel lines 8-10, substitute the following at line 8:
-- These and other features of the invention(s) will become clearer with
reference to the following detailed description of the presently preferred
embodiments and accompanied drawings.

DESCRIPTION OF THE DRAWINGS--;

- 20 in line 11, cancel "shows" substitute --is a block diagram of-- therefor;
in line 12, cancel the comma substitute a period therefor;
in line 14, cancel the comma substitute a period therefor;
in line 17, cancel the comma substitute a period therefor;
in line 20, cancel "invention," substitute --present invention.-- therefor;
25 below line 20, insert a centered heading:

**--DETAILED DESCRIPTION OF THE PRESENTLY PREFERRED
EMBODIMENTS--;**

- in line 23, after "network" insert --(not shown)--.

On page 7, at the top of the page, cancel "GR 97 P 2121 P";
in line 32, cancel "are" substitute --is-- therefor.

On page 8, at the top of the page, cancel "GR 97 P 2121 P".

On page 9, at the top of the page, cancel "GR 97 P 2121 P".

5 On page 10, at the top of the page, cancel "GR 97 P 2121 P".

On page 11, at the top of the page, cancel "GR 97 P 2121 P";
below line 13, insert a paragraph:

-- Although modifications and changes may be suggested by those of
ordinary skill in the art, it is the intention of the inventors to embody within the
10 patent warranted hereon all changes and modifications as reasonably and properly
come within the scope of their contribution to the art.--.

Cancel page 12.

IN THE CLAIMS:

On page 13, at the top of the page, cancel "GR 97 P 2121 P";

in line 1, cancel "Patent Claims" substitute --**WE CLAIM AS OUR**

INVENTION:-- therefor.

5 Please cancel claims 1-10 and substitute the following claims 11-20
therefor:

11. A method for digital radio transmission of data between a fixed
station and at least one mobile station at one of a number of carrier frequencies,
said method comprising the steps of:

10 transmitting data in a number of time slots using a time-division multiplex
 method, said data being transmitted in active time slots each of
 which is followed by an inactive time slot in which no data is
 transmitted, said inactive time slot having a time duration shorter
 than a time duration of an active time slot; and
15 changing from a first carrier frequency to a second carrier frequency after a
 predetermined time period having an order of magnitude of one
 time slot.

12. The method according to claim 11, wherein a time duration of an
inactive time slot is half that of a time duration of an active time slot.

20 13. The method according to claim 11, wherein said data is transmitted
using a time-division multiplex duplex method.

14. The method according to claim 11, wherein a transmission frame
has four active time slots for transmitting from said fixed station to said mobile
station and four time slots for transmitting from said mobile station to said fixed
25 station.

15. The method according to claim 11, wherein said data is transmitted
in a 2.4 GHz band.

16. An arrangement for digital radio transmission of data between a fixed station and at least one mobile station in a number of time slots using the time-division multiplex method, and at a number of carrier frequencies using the frequency-division multiplex method, said arrangement comprising:

- 5 a fixed station having a first RF module for choosing a carrier frequency for transmitting during one of said time slots, and for changing from a first carrier frequency to a second carrier frequency during a predetermined time period on an order of magnitude of one time slot;
- 10 at least one mobile station having a second RF module for choosing a carrier frequency for transmitting during one of said time slots, and for changing from said first carrier frequency to said second carrier frequency during said predetermined time period on an order of magnitude of one time slot; and
- 15 a transmission time frame having active time slots in which data is transmitted, each of said active time slots being followed by an inactive time slot in which no data is transmitted, said inactive time slot having a time duration being shorter than that of a time duration of an active time slot.

20 17. The arrangement according to claim 16, wherein said time duration of said inactive time slot is half that of said duration of said active time slot.

18. The arrangement according to claim 18, wherein said transmission frame comprises four active time slots for transmitting from said fixed station to said mobile station, and four time slots for transmitting from said mobile station to
25 said fixed station.

19. The arrangement according to claim 16, wherein said carrier frequencies are in a 2.4 GHz band.

20. The arrangement according to claim 16, wherein said first and second RF modules change said carrier frequencies during an inactive time slot.

IN THE ABSTRACT:

On page 15, cancel lines 1-5, insert the following centered heading at line

5 1:

--ABSTRACT OF THE DISCLOSURE--;

cancel lines 6-23, substitute the following abstract therefor:

-- According to the present invention, a method and an arrangement are provided for digital radio transmission of data between a fixed station and at least one mobile station at one of a number of carrier frequencies, the data being transmitted in a number of time slots using a time-division multiplex method. The change from one carrier frequency to another carrier frequency requires a predetermined time period when so-called slow hopping RF modules are used. The data is transmitted in active time slots, which are each followed by an inactive time slot in which no data is transmitted and which is sufficient for the RF modules to program the frequency for the next active time slot. According to the present invention, the time duration of the inactive time slot is shorter than that of an active time slot.--.

REMARKS:

The present Amendment revises the specification, drawings and claims to conform to United States patent practice, before examination of the present application. All of the changes are editorial and no new matter is added thereby.

5 The cancellation of claims 1-10, in favor of new claims 11-20, has been made solely for convenience, since the amount of bracketing and underlining necessary to editorially amend claims 1-10 in order to conform to United States patent practice would have been excessive and burdensome. The cancellation of claims 1-10 is therefore not intended to be a surrender of any of the subject matter of
10 those claims.

Early examination on the merits is respectfully requested.

Respectfully submitted,

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GR 97 P 2121 P'

Description

Method and arrangement for effective radio transmission of data

5 The present invention relates to a method and an arrangement for effective radio transmission of data between a fixed station and at least one mobile station at one of a plurality of carrier frequencies, the data being transmitted in time slots using a time-division multiplex method (TDMA).

10 The DECT Standard was adopted at the start of the 1990s in order to replace the various existing analogue and digital Standards in Europe. This is the first common European Standard for cordless telecommunications. A DECT network is a microcellular, digital mobile radio network
15 for high subscriber densities. It is primarily designed for use in buildings. However, it is also possible to use the DECT Standard outdoors. The capacity of the DECT network of around 10,000 subscribers per square kilometer provides, from the cordless Standard, ideal access
20 technology for network operators. According to the DECT Standard, it is possible to transmit both voice and digital signals. Thus, cordless data networks can also be built on a DECT basis.

25 The DECT Standard will be explained in more detail in the following text with reference to Fig. 2. A digital, cordless telecommunications system for ranges of less than 300 m has been standardized for Europe under the designation DECT (Digital Enhanced Cordless Telecommunication). In conjunction with the switching func-
30 tion of a telecommunications system, this system is therefore suitable for mobile telephone and data traffic in an office building or on a commercial site. The DECT functions supplement a telecommunications installation, and thus make it the fixed station FS of the cordless
35 telecommunications system. Digital radio links between the fixed station FS and a maximum of 120 mobile stations MS can be produced, monitored and controlled on up to 120

channels.

A maximum of ten different carrier frequencies (carriers) are used for transmission in the frequency range from 1.88 GHz to 1.9 GHz. This frequency-division
5 multiplex method is called FDMA (Frequency Division Multiple Access).

Twelve channels are transmitted successively in time on each of the ten carrier frequencies using the time-division multiplex method TDMA (Time Division
10 Multiple Access). Cordless telecommunication in accordance with the DECT Standard using ten carrier frequencies with in each case twelve channels per carrier frequency provides a total of 120 channels. Since one channel is
15 required, for example, for each voice link, there are 120 links to the maximum of 120 mobile stations MS. The duplex method (TTD) is used on the carriers. Once the twelve channels (channels 1 - 12) have been transmitted, the system switches to receive, and the twelve channels (channels 13 - 24) in the opposite direction are
20 received.

A time-division multiplex frame thus comprises 24 channels (see Fig. 2). In this case, channel 1 to channel 12 are transmitted from the fixed station FS to the mobile stations MS, while channel 13 to channel 24
25 are transmitted in the opposite direction, from the mobile stations MS to the fixed station FS. The frame duration is 10 ms. The duration of a channel (time slot) is 417 μ s. 320 bits of information (for example voice) and 100 bits of control data (synchronization, signalling
30 and error check) are transmitted in this time. The useful bit rate for a subscriber (channel) results from the 320 bits of information within 10 ms. It is thus 32 kilobits per second.

Integrated modules have been developed to carry
35 out the DECT functions for fixed and mobile stations. In this case, the fixed station and the mobile station carry out similar functions. One of these said integrated modules is in this case the RF module, that is to say the module which carries out the actual function of receiving

and transmitting the RF band.

It is known for so-called fast hopping RF modules to be used, that is to say RF modules which can carry out a change in the carrier frequency from one time slot or channel to the next. These fast hopping RF modules are intrinsically very complex and costly. Thus, in practice, so-called slow hopping RF modules are mainly used, that is to say modules which require a certain amount of time to change the carrier frequency for the next time slot. The time period which the slow hopping RF module requires to change the carrier frequency corresponds essentially to the time period of one time slot. This means that, after each active time slot, that is to say after each slot in which data are transmitted, a so-called inactive time slot (blind slot) must follow, in which no data can be transmitted. This means that, in practice, only six links are available on one carrier frequency to the DECT standard, instead of the twelve possible links.

A DECT channel is defined by its time slot and its carrier frequency. In this case, it should be noted that, according to the DECT Standard, the organization to reuse physical channels is carried out by means of dynamic channel selection. This means that there is no need for any complex frequency planning, as in cellular systems. To set up a link, the signal levels of all the channels are measured continuously, and the interference-free channels are controlled in a channel list (channel map). While a link exists, the signal levels of all the channels and the reception quality continue to be monitored. If this monitoring indicates that the channel currently being used has been transmitted at a carrier frequency which is subject to interference (for example as a result of the influence of a transmission at the same carrier frequency from or to another fixed station), another carrier frequency is automatically selected for the next active time slot, and is entered in the channel list as being interference-free.

As an alternative, a so-called frequency hopping method can also be used, in which the carrier frequency

is changed after a predetermined time period, for example a transmission frame.

For nations outside Europe, the DECT Standard may need to be modified and matched to local conditions. For example, in the USA, the normal DECT band between 1.88 and 1.90 GHz cannot be used for transmission, and the generally accessible 2.4 GHz ISM band (Industrial, Scientific, Medical) is available instead of this. Furthermore, changes would have to be carried out for matching to the national Standards, such as the American Standard "FCC part 15" (Federal Communications Commission). This American Standard describes the transmission method, transmission powers and available bandwidth allowed for the radio interface.

In the DECT Standard, in addition to the 320 information bits mentioned above, each time slot also contains another 104 bits required for signal transmission, as well as 56 bits in a guard field, so that each time slot contains a total of 480 bits. This results in a data rate of $(24 \times 480 \text{ bits})/10 \text{ ms} = 1\,152\,000 \text{ bits/s}$. A data rate at this level is pointless in the American ISM band, since the bandwidth required per usable channel would be too large.

The present invention thus has the object of providing a method and an arrangement for digital radio transmission of data, which uses the bandwidth of a TDMA system effectively. The method and the arrangement are intended to allow, in particular, cost-effective use of the said slow hopping RF modules.

Thus, according to the invention, a method is provided for digital radio transmission of data between a fixed station and at least one mobile station at one of a plurality of carrier frequencies. The data are in this case transmitted in time slots using a time-division multiplex method (TDMA). The change from one carrier frequency to another carrier frequency is in this case carried out in a predetermined time period.

The data are transmitted in active time slots, each of which is followed by an inactive time slot in

which no data are transmitted. According to the invention, the time duration of the inactive time slot is shorter than that of the active time slot.

5 In particular, the time duration of the inactive time slot may be half that of the active time slot. This time slot structure allows more active links to be created per time frame, which results in more effective utilization of the bandwidth of the TDMA system.

10 A transmission time frame may, in particular, contain four active time slots for transmitting from the fixed station to the mobile station, as well as four time slots for transmitting from the mobile station to the fixed station.

15 The transmission can take place in a 2.4 GHz band.

Furthermore, an arrangement for radio transmission of data is provided according to the invention. The arrangement according to the invention has a fixed station and at least one mobile station, between which
20 the data can be transmitted in a plurality of time slots using the time-division multiplex method (TDMA), and at a plurality of carrier frequencies using the frequency-division multiplex method (FDMA). The fixed station and the at least one mobile station each have an RF module,
25 by means of which the carrier frequency for transmitting during one of the time slots can be chosen. In this case, the RF modules require a predetermined time duration in the order of magnitude of one time slot to change from one carrier frequency to another carrier frequency.
30 According to the invention, a transmission time frame has active time slots in which data are transmitted, each followed by an inactive time slot, in which no data are transmitted. The time duration of the inactive time slot is, in particular, shorter than that of the active time
35 slot. It is particularly advantageous if the time duration of the inactive time slot is half that of the active time slot. This makes it possible to ensure that more active links can be created during a time frame, and that the bandwidth is thus used more effectively.

A transmission time frame may contain four active time slots for transmitting from the fixed station to the mobile station, as well as four time slots for transmitting from the mobile station to the fixed station.

5 The carrier frequencies may be in a 2.4 GHz band.

The RF modules may, in particular, change the carrier frequencies during an inactive time slot.

The invention will now be explained in more detail using an exemplary embodiment and with reference
10 to the accompanying drawings, in which:

Fig. 1 shows an arrangement according to the invention for digital radio transmission of data,

Fig. 2 shows a schematic illustration of the known DECT Standard,

15 Fig. 3 shows a schematic illustration of the channel allocation for matching the known DECT Standard to the American ISM band,

Fig. 4 shows a particularly effective allocation of the channels from the DECT Standard matched to the
20 ISM band, according to the invention,

Fig. 1 shows an arrangement for digital radio transmission of data. A fixed station 1 is in this case connected to the fixed network by means of a terminal line 10. The fixed station 1 has an RF module 4, with
25 which data can be transmitted and received by means of an antenna 6. The RF module 4 may be, in particular, a so-called slow hopping RF module, that is to say a particularly cost-effective RF module, which intrinsically requires a certain period of time to change from one
30 carrier frequency to another carrier frequency. This time period is in the order of magnitude of a time slot, that is to say between about 100 μ s and 1 ms, and, in particular, between about 300 μ s and 500 μ s. This time period required for the carrier frequency change may correspond,
35 for example, to the time period which is filled by a time slot in a time-division multiplex method (TDMA). By means of the antenna 6, a radio transmission may be made via a radio transmission path 8 to a mobile station 2, or a radio transmission may be made to a mobile station

(cordless telephone) 3 via a second radio transmission path 9. All the mobile stations illustrated in Fig. 1 are of the same design, so that a more detailed explanation will be given only on the basis of the illustrated mobile station 2.

As can be seen in Fig. 1, this mobile station 2 has an antenna 7 for receiving and for transmitting data from and, respectively, to the fixed station 1. The mobile station 2 contains an RF module 5, which essentially corresponds to the RF module 4 used in the fixed station 1. The RF module 5 of the mobile station 2 may thus also be a so-called slow hopping RF module.

It is now intended to explain, with reference to Fig. 2, how the known DECT Standard can be matched to the American ISM band. As already mentioned above, if the DECT Standard were retained, the resulting data rate would be too high for the ISM band. As can be seen in Fig. 3, the number of time slots per frame is for this reason halved, that is to say only 12 time slots Z1 - Z12 are now provided in the ten milliseconds of a time frame instead of the 24 time slots (channels) in the DECT Standard, each of which 12 time slots can be used to transmit 480 bits. By halving the number of time slots, the data rate is also halved, in a corresponding manner, to $(12 \times 480 \text{ bits})/10 \text{ ms} = 576000 \text{ bits/s}$. This lower data rate results in a bandwidth that is acceptable for the American ISM band.

As can be seen, per se, in Fig. 3, it is necessary to provide so-called slow hopping RF modules in a cost-effective implementation of the equipment required for radio transmission, which means that each active time slot in which data are transmitted must be followed by an inactive time slot (blind slot), in which no data can be transmitted. If twelve time slots Z1 - Z12 are provided (6 time slots Z1 - Z6 for transmission from a mobile station to the fixed station and 6 time slots Z7 - Z12 for transmission from the fixed station to a mobile station), then there is a maximum of only three possible links available. In an implementation using the cost-effective

slow hopping RF modules, the usable channel capacity is thus not very great as a result of the regulation by the slow hopping RF module to a maximum of three links.

Possible active time slots are illustrated shaded in Fig. 3. For example, as illustrated, transmission from the fixed station 1 to a mobile station 2, 3 can be made at the carrier frequency f_2 in the time slot Z1 (RX1). If this time slot Z1 is followed by a time slot Z2, in which no data transmission takes place (inactive time slot, blind slot), a slow hopping RF module can also use the time duration of the inactive time slot Z2 to change the carrier frequency. As illustrated in Fig. 3, the carrier frequency can be changed, for example, from the carrier frequency f_2 to the carrier frequency f_1 . Thus, as illustrated in Fig. 3, a transmission can be made in the time slot Z3 from the fixed station to a mobile station, at the carrier frequency f_1 (RX2). The layout shown in Fig. 3 is thus distinguished by the fact that, with the given time slot distribution, an active time slot (illustrated shaded) can be operated at each of the predetermined carrier frequencies ($f_1, f_2 \dots$).

It should be remembered that, according to the DECT Standard, the organization of reuse of physical channels is carried out by means of dynamic channel selection, a channel being defined by its carrier frequency and its time slot. There is thus no need for any complex frequency planning, as in cellular systems. To set up links, the signal levels of all the channels are measured continuously, and the interference-free channels are controlled in a channel list (channel map). During a link, the signal levels of all the channels of all the possible carrier frequencies, and the reception quality, continue to be monitored.

Thus, as illustrated in Fig. 3, if it is found in the time slot Z1 when transmitting (RX1) at the carrier frequency f_2 that the reception or transmission conditions are better at the carrier frequency f_1 , then it is possible to change, during the time duration of the time slot Z2 in which no data transmission takes place, to the

carrier frequency 1 which has been identified as being better. The transmission RX2 takes place during the time slot Z3 at the carrier frequency f_2 which has been identified as being better.

5 As an alternative, a so-called frequency hopping method can also be used, in which the carrier frequency is changed after a predetermined time period, for example a transmission frame.

10 As already stated, the channel allocation scheme illustrated in Fig. 3 has the disadvantage that, since the number of time slots per time frame is halved to 12, as a result of which the duration of a time slot is doubled to 833 μ s, and as a result of the necessity for the inactive time slots after each active time slot, this
15 results in only three possible links (three links from a fixed station to a mobile station and three links from a mobile station to a fixed station) being available, in contrast to the six possible links according to the DECT Standard.

20 Fig. 4 illustrates a time slot structure which allows the maximum possible number of links to be increased from three to four without there being any negative effect on flexible selection of the carrier frequencies from one active time slot to the next active
25 time slot. As can be seen in Fig. 4, this increase in the maximum number of links from three to four is essentially achieved by the time duration of an inactive slot, during which no data transmission takes place, being shortened in comparison with the time duration of an active time
30 slot. As is shown in Fig. 4, the time duration of an active time slot Z1, Z3, Z5, Z7, Z9, Z11, Z13 and Z15 in a time frame is in each case 833 ms, if the time frame lasts for 10 ms overall. The time duration of the inactive time slots Z2, Z4, Z6, Z8, Z10, Z12, Z14 and Z16
35 is only 417 μ s, as illustrated in Fig. 4, and is thus essentially only half the time duration of the active time slots. A slow hopping RF module known from DECT technology requires a time period of at least 417 μ s after an active time slot, in order to carry out fre-

quency programming for the carrier frequency of the next time slot. Half a time slot of the DECT Standard matched to the ISM band, with a time duration of $833 \mu\text{s}/2 = 417 \mu\text{s}$, is thus sufficient as an inactive time slot (blind slot).

As can be seen in Fig. 4, a data transmission RX1, for example, can be made during the time slot Z1 from the fixed station to a mobile station at a carrier frequency f_1 . In order to allow the transmission to be made with a low bandwidth as well, the time duration of the time slot Z1 is in this case twice the time duration according to the DECT Standard, namely $833 \mu\text{s}$. The time slot Z1 is followed by an non-active time slot Z2, whose time duration is only $417 \mu\text{s}$. This time period of $417 \mu\text{s}$ is intrinsically sufficient for an RF module using the slow hopping technique to program the carrier frequency for the next active time slot Z3. If it is thus found that, for example, the carrier frequency f_3 offers better reception conditions than the carrier frequency f_1 , it is possible, during the time duration of the time slot Z2 during which no data transmission takes place, to change the carrier frequency from the carrier frequency f_1 in the time slot Z1 to the carrier frequency f_3 in the time slot Z3, and transmission from a fixed station to a mobile station can thus take place during the time slot Z3 (RX3).

The illustrated example shows the case where the carrier frequency f_x is not changed for transmitting between a fixed station and a specific mobile station.

As an alternative, a so-called frequency hopping method can, of course, also be used, in which the carrier frequency is changed after a predetermined time period, for example a transmission frame.

After eight time slots Z1 to Z8, which correspond to half the time slots Z1 to Z16 in a time frame of 10 ms, the mobile station or stations transmit to the fixed station using the duplex method (TTD). For example, a mobile station can transmit (TX1) to the fixed station at a carrier frequency f_1 during the time slot Z9. The

inactive time slot Z10 following the active time slot Z9 once again lasts for only half the time duration of the active time slot Z9 (833 μ s), namely 417 μ s. The time duration of the inactive half time slot Z10 is in turn
5 sufficient for the RF module to carry out the frequency programming for the next active time slot Z11, for a further transmission from a mobile station to the fixed station (TX2).

The structure of the time slots ZX according to
10 the invention thus allows more efficient use to be made of the time frame for digital transmission in the TDMA system, without this resulting in any loss of flexibility in the choice of the carrier frequencies.

List of reference symbols

- 1: Fixed station
- 2: Mobile station (cordless telephone)
- 3: Mobile station
- 5 4: RF module, fixed station
- 5: RF module, base station
- 6: Antenna, fixed station
- 7: Antenna, mobile station
- 8: First radio transmission path
- 10 9: Second radio transmission path
- 10: Terminal line
- Zx: Time slots
- f_x : Carrier frequency

Patent Claims

1. Method for digital radio transmission of data between a fixed station (1) and at least one mobile station (2, 3) at one of a plurality of carrier frequencies (f_1, f_2, \dots), in which
 - 5 the data are transmitted in a plurality of time slots (Z_1, Z_2, \dots) using a time-division multiplex method (TDMA),
 - 10 the change from one carrier frequency to another carrier frequency requires a predetermined time period in the order of magnitude of one time slot, and
 - 15 the data are transmitted in active time slots (Z_1) each of which is followed by an inactive time slot (Z_2) in which no data are transmitted, and in which
 - the time duration of an inactive time slot (Z_2) is shorter than that of an active time slot (Z_1).
2. Method according to Claim 1, characterized in that
 - 20 the time duration of an inactive time slot (Z_2) is half that of an active time slot (Z_1).
3. Method according to Claim 1 or 2, characterized in that a time-division multiplex duplex (TDD) method is used.
- 25 4. Method according to one of Claims 1 to 3, characterized in that a transmission time frame contains four active time slots (Z_1, Z_3, Z_5, Z_7) for transmitting from the fixed station (1) to the mobile station (2), and four time slots ($Z_9, Z_{11}, Z_{13}, Z_{15}$) for transmitting from the mobile station
 - 30 (2) to the fixed station (1).
5. Method according to one of the preceding claims, characterized in that the transmission takes place in a 2.4 GHz band.
- 35 6. Arrangement for digital radio transmission of data, having a fixed station (1) and at least one mobile station (2, 3), between which the data can be transmitted in a plurality of time slots (Z_1, Z_2, \dots) using the

time-division multiplex method (TDMA), and at a plurality of carrier frequencies (f_1, f_2, \dots) using the frequency-division multiplex method (FDMA),

- the fixed station (1) and the at least one mobile station (2, 3) each having an RF module (4, 5) by means of which the carrier frequency for transmitting during one of the time slots can be chosen,
- RF modules (4, 5) require a predetermined time period in the order of magnitude of one time slot to change from one carrier frequency to another carrier frequency, and
- a transmission time frame has active time slots (Z1) in which data are transmitted, each of which is followed by an inactive time slot (Z2) in which no data are transmitted,
- the time duration of the inactive time slot (Z2) is shorter than that of the active time slot (Z1).

7. Arrangement according to Claim 6, characterized in that the time duration of the inactive time slot (Z2) is half that of the active time slot (Z1).

8. Arrangement according to one of Claims 6 or 7, characterized in that a transmission time frame contains four active time slots (Z1, Z3, Z5, Z7) for transmitting from the fixed station (1) to the mobile station (2), and four time slots (Z9, Z11, Z13, Z15) for transmitting from the mobile station (2) to the fixed station (1).

9. Arrangement according to one of Claims 6 to 8, characterized in that the carrier frequencies are in a 2.4 GHz band.

10. Arrangement according to one of Claims 6 to 9, characterized in that the RF modules (4, 5) change the carrier frequencies during an inactive time slot.

Abstract

Method and arrangement for effective radio transmission of data

According to the invention, a method and an arrangement are provided for digital radio transmission of data between a fixed station (1) and at least one mobile station (2, 3) at one of a plurality of carrier frequencies (F1, F2 ...), the data being transmitted in a plurality of time slots (Z1, Z2 ...) using a time-division multiplex method. The change from one carrier frequency to another carrier frequency requires a predetermined time period when so-called slow hopping RF modules are used. The data are transmitted in active time slots, which are each followed by an inactive time slot in which no data are transmitted and which is sufficient for the RF modules to programme the frequency for the next active time slot. According to the invention, the time duration of the inactive time slot is shorter than that of an active time slot.

Figure 1

1/2

FIG 1

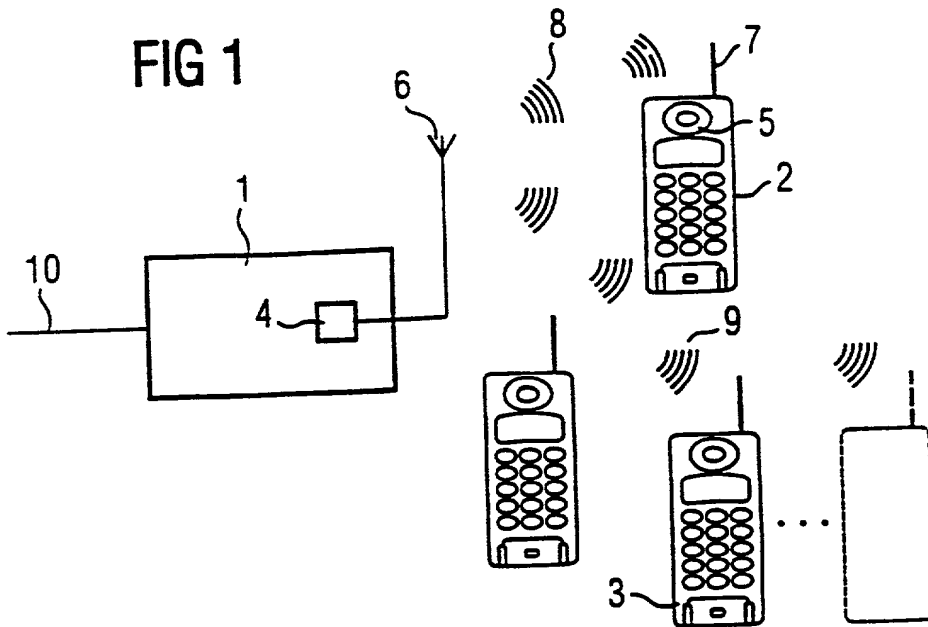
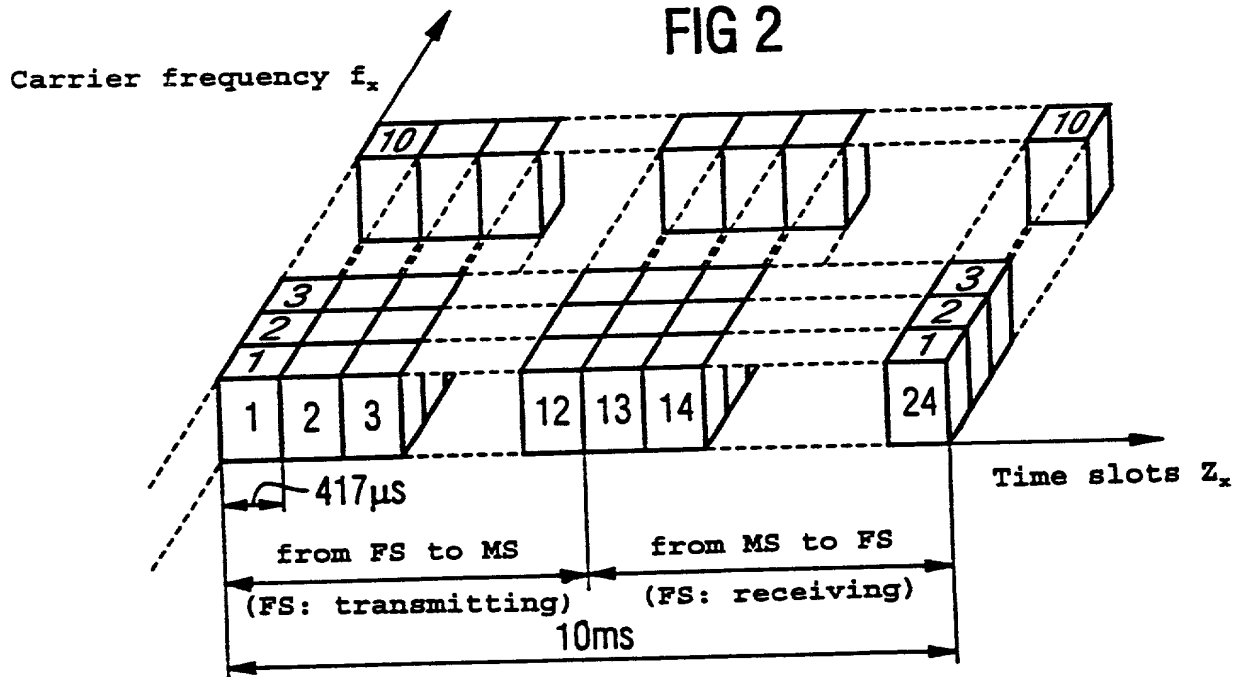


FIG 2



2/2

FIG 3

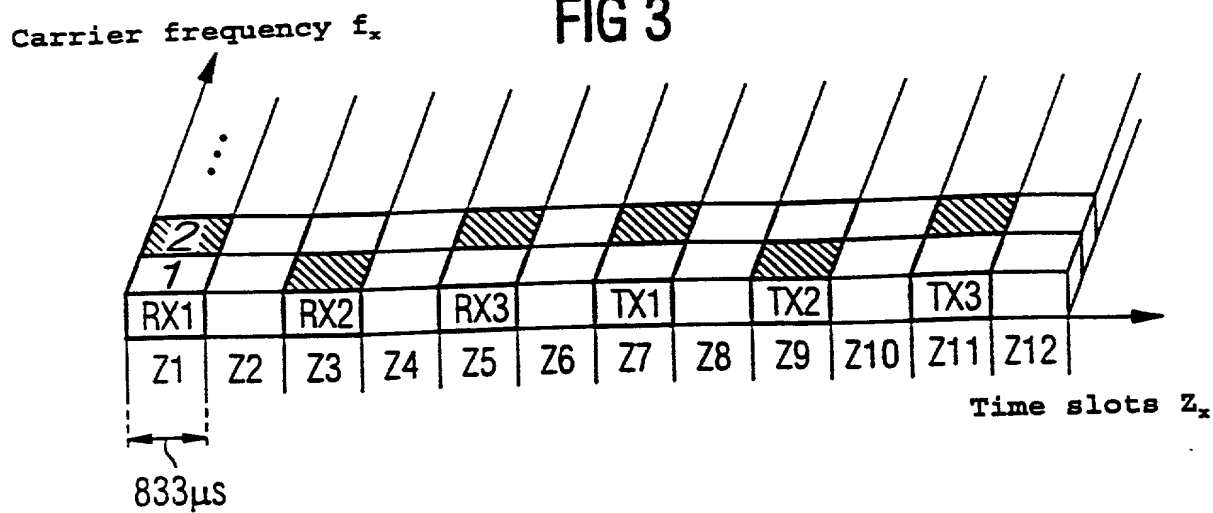
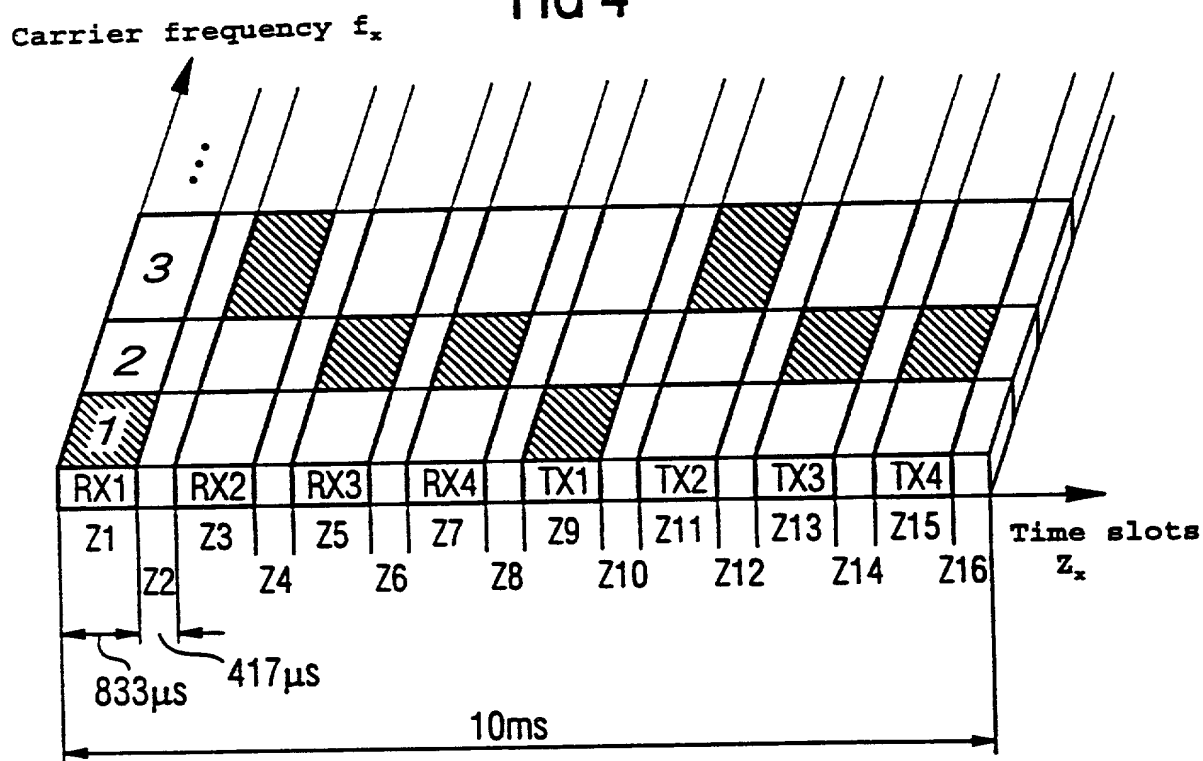


FIG 4



Filed PCT/PTO 16 MAR 2001



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Method and arrangement for effective radio transmission of data

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☒ was filed on 14 August 1997 as
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Prior foreign applications
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PCT/DE97/01315 PCT

(Number) (Country)
(Nummer) (Land)

24 JUNE 1997

(Day Month Year Filed)
(Tag Monat Jahr eingereicht)

(Number) (Country)
(Nummer) (Land)

(Day Month Year Filed)
(Tag Monat Jahr eingereicht)

(Number) (Country)
(Nummer) (Land)

(Day Month Year Filed)
(Tag Monat Jahr eingereicht)

Priority Claimed

☒ ☐
Yes No
Ja Nein

☐ ☐
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☐ ☐
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